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Participation of soil invertebrates in the migration of ash elements

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With 3 figures

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The researches into soil dwellers involved in the migration of chemical elements in biogeocoenosis are developing far slower than the studies of the pedobiont contribution to the plant litter decomposition, although both these processes appear to be quantitatively comparable.

In the USSR there are few investigations of ash content and composition of the body of soil animals and their diet (GILJAROV 1957, 1965, PONOMARENKO et al. 1974) and the quantative aspect of this problem is unknown. Due to this, the purpose of the present paper is to estimate quantitatively the role of pedobionts on the basis of our own and published data. This turnover is relatively limited (soil-plant-fall-soil) and on the whole has been studied by the geobotanists and soil researchers (RODIN i BAZILEVIČ 1965) who have not attached importance to the role of soil dwellers in this process probably because of low animal biomass and a small amount of accumulated elements in this biomass.

The data on animal biomass are estimated or quoted from following sources: M. S. GILJAROV (1957: Ukraine, Belovodsk). G. F. KURČEVA (1971: Kursk). B. R. STRIGANOVA and R. RACHMANOV (1973: Azerbaijan, Lenkoran), on biomass of leaf-fall from: T. P. KOKOVINA (1967: Kursk). S. V. ZONN (1964: Belovodsk). L. E. RODIN and N. I. BAZILEVIČ (1965: Lenkoran). Biomass of Diplopoda and leaf-fall in Pistacia forest were estimated on a sample plot (25 m^2). Calcium and magnesium contents were determined by trilonometric method with mureksid and chromogen black indicators. Potassium content was determined by flame photometry. Data on chemical composition of the leaf-fall are also quoted from T. P. KOKOVINA (1967) and leaf-fall and Diplopoda from M. S. GILJAROV (1957.

The calcium, potassium and magnesium contents in animal biomass are 3—5 orders lower than those in phytomass (Fig. 1) and order of values is not changed if the animal productivity is taken into account. In some cases the content of an element under investigation in biomass of such important soil forming animals as Diplopoda is comparable with that in leaf-fall but there is no direct dependance between these values (Fig. 2).

Element contents in biomass do not reflect the actual role of soil dwellers in the biogeochemical turnover of elements, i. e. the consumption and destruction of plant litter by soil animals promotes the return of the elements to the soil, otherwise these elements may be leached by rainfall. Microflora prevents up to 22 % of Ca-45 and Sr-90 and 24 % of Cs-137 at 25 °C in Liriodendron leaves (WITKAMP 1969). In oak forest from live leaves are leached 330 mg/m^2 K, 600 mg/m^2 Ca and 120 mg/m^2 Mg by rainfall during the vegetative period (SVIRIDOVA 1960). Diplopoda can transfer with food up to 75 mg/m^2 Ca and 12.5 mg/m^2 Mg in oak forests of forest-steppe of the European part of the USSR (the data on the leaf fall consumed are quoted from G. F. KURČEVA (1965). These figures increase by 1/6, if it ie taken into account that Diplopoda diets contain 1/3 the soil (SOKOLOV 1957). In the sama area an earthworm maximum biomass can transfer through population up to 10 g/m^2 Ca and 2 g/m^2 Mg monthly (soil in earthworms gut content composes up to 90 % (PEREL' i SOKOLOV 1964) and 10—30 % dry weight food on 1 g wet weight body is consumed by earthworms daily (CROSSLEY et al. 1971).

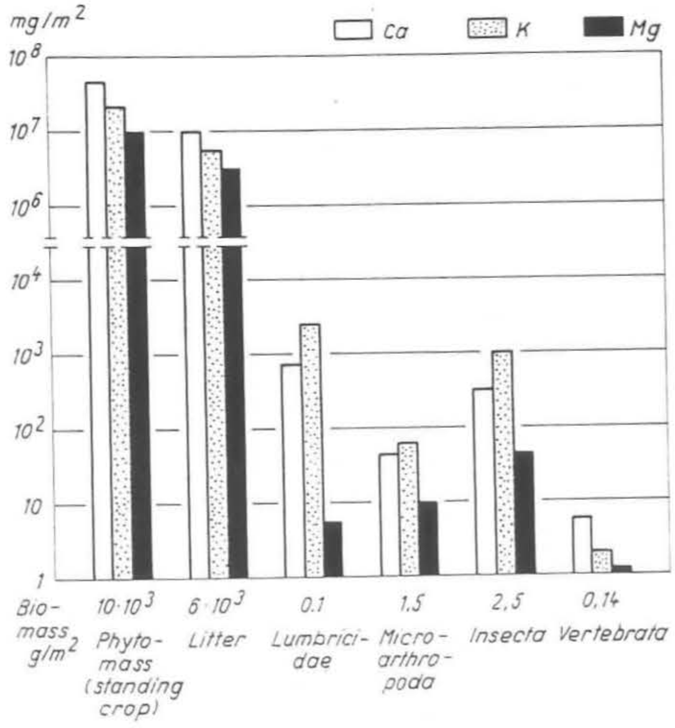

Fig. 1. The distribution of calcium, magnesium and potassium in the biomass of different compartments of the biogeocoenosis. Erratum: The biomass of Lumbricidae amounts 0.7 instead of 0.1 kg/m².

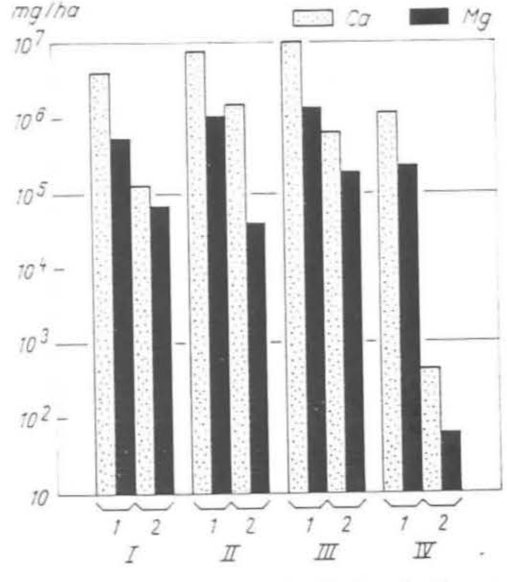

Fig. 2. The distribution of calcium and magnesium in Diplopoda biomass and leaf-fall in different zonal landscapes. (1) leaf-fall, (2) Diplopoda. (I) Forest-steppe oak forest, Kursk, the European part of the USSR; (II) Steppe oak stand, Derkul, Belovodsk, the Ukraine; (III) Deciduous iron wood forest, Lenkoran, Azerbaijan; (IV) Pistacia stand, Badkhys, Turkmenie.

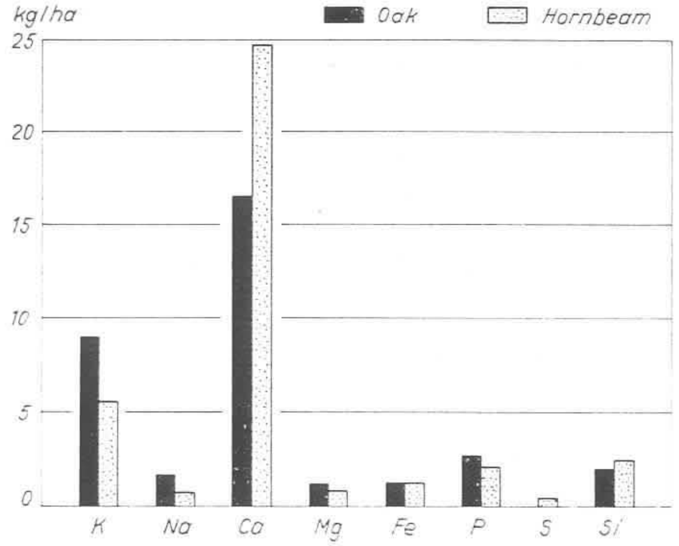

Fig. 3. The quantity of chemical elements released by earthworms from the leaf-fall (after Zajonc 1971. Tab. 5).

In Ghircan forest (Lenkoran) Diplopoda consume up to 600 kg leaf-fall on 1 ha in a year (Striganova i Rachmanov 1973), which, on our data contains 10.2 kg/ha Ca and 1.35 kg/ha Mg. In West Europe earthworms in beech-oak forests release from leaf-fall about 105 kg/ha of ash elements in a year (Fig. 3, after Zajonc 1971, Tab. 5), and in the soil of meadow biogeocoenosis in horizon A_h earthworms secrete annually about 25 kg of casts per sq.m. containing 3.42 g P and 11.15 g K (Graff 1971). Desert woodlice *Hemilepistus* sp. excavate with faeces onto the soil surface 2.5 g/m^2 Ca and 0.76 g/m^2 Mg during 3 months (estimate after Lašak 1954), that exceeds the value of these elements in plant-fall. These data give ground to assume that by trophic activity soil animals involve in the turnover the amount of elements comparable with the element content in plant-fall (10—300 %). It should be noted that animals return the elements to the soil in chemical form different as compared with plants. In the course of moulting Diplopoda return calcium as carbonate (one individual *Schizophyllum sabulosum* secretes 150 mg $CaCO_3$ during the life (Byzova 1970). Calcium carbonate as calcite is formed during consumption of oak fall by earthworms (Ponomareva 1948). In faeces of woodlice and larvae of Diptera there is a higher content of available phosphorus as compared with that in the soil (Kozlovskaja 1965).

But the role of pedobionts in biogeochemical turnover is not restricted only to the decomposition of plant litter. In the course of digging and nestbuilding activity soil dwellers change the chemical composition of the environment. Earthworms, ants, termites excavate calcium from deep soil layers (Dimo 1958) or cause conditions for calcium accumulation in a nest (Lee and Wood 1971). It is known, that chemical composition of ant and termite nests differ from surrounding soil. By accumulation of plant material in nests, ants cause "points" of concentration of nutrient elements in the biogeocoenosis and alter the structure of the biochemical cycle.

Therefore, soil invertebrates affect actively the biogeochemical turnover by returning chemical elements from the plant fall to the soil and create accumulation points of nutrient elements in nestbuilding activity.

Summary

The content of chemical elements in an animal biomass is far lower that in phytomass, although in some cases the value of some elements in pedobiont biomass and leaf-fall is comparable. However, the population of soil dwellers transfer 10—300% of nutrient content in leaf-fall in process of its trophic activity. Soil animals influence the structure of a biochemical turnover by creation of "points" of nutrient concentration in biogeocoenosis by nestbuilding and digging activity.

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